The specimen only differs from Mr. Hallowell's figure in being marked with brown lines beneath, and in having more elongate claws; and I strongly suspect that they are both the same species.

VII.—*Experimental Researches upon the Position of the Centre of Gravity in Insects.* By Félix Plateau*.

The study of the conditions of equilibrium of living creatures, I need scarcely say, is only possible when we know in each of them the situation of the *centre of gravity*. Now that the knowledge of the mechanics of the Articulata has made considerable progress, thanks to the employment of processes of investigation borrowed from physics, it seemed to me that it would be really useful to describe an easy method of investigating the centre of gravity of the Articulata, and to give an account of the results which its application to insects has enabled me to obtain.

Unfortunately I cannot, in a mere summary, give a description of the instrument I have employed. A mere short description without a figure is of necessity obscure and of no use at all. I shall only say that this instrument nearly reproduces, on a small scale and with some improvements, that which was invented by Borelli to determine the position of the centre of gravity in man. As to the results of my experiments, I must likewise refrain from giving them under the form which they take in my memoir—that is to say, in the shape of a considerable number of figures brought together in several tables. I shall therefore confine myself to the indication of the general conclusions which I have thought I might deduce from them, supporting these, where necessary, by a few examples.

1. The centre of gravity of insects is situated in the vertical median plane which passes through the longitudinal axis of the body.

2. It occupies a very nearly identical position in insects of the same species and of the same sex in the same attitude.

3. It is rarely that the external form of the body allows us to determine, *without experiment*, the exact position of the centre of gravity. I shall cite, as an example, the results furnished by the family of the Odonata. All its representatives have nearly the same external aspect; and yet, notwithstanding this quasi-identity of structure, I have found the

* Bibliothèque Universelle: Archives des Sciences Physiques et Naturelles, tome xliii. 1872, from an abstract communicated by the author.

following differences in the relative positions of the centre of gravity:—

Agrion puella ♀. First third of the third abdominal segment.
Agrion sanguinea. Posterior margin of the second abdominal segment.
Libellula conspurcata ♀. Posterior margin of the metathorax.
Libellula vulgata ♀. Furrow between thorax and abdomen.
Cordulia metallica ♀. Posterior margin of the metathorax.
Æschna grandis ♀. Middle of the second abdominal segment.

4. The centre of gravity does not occupy the same position in the two sexes of the same species; it is sometimes more and sometimes less backward in the females than in the males, and its situation depends upon the relations existing between the various dimensions of the individuals.

It might have been supposed that the centre of gravity was always situated further back in the females, the abdomen of which is generally more voluminous than that of the males. I have observed the opposite condition in the females of *Oryctes nasicornis*, *Libellula vulgata*, and *Agrion puella*.

5. During the metamorphosis of the larva into the perfect insect, the *relative* centre of gravity approaches the head; the *absolute* centre of gravity, on the contrary, departs from it*.

This apparent contradiction is easily explained. The thorax of larvæ is generally very much reduced and the segments of the abdomen numerous. The centre of gravity therefore falls inevitably in an abdominal segment. In the perfect insect the thorax has acquired considerable dimensions, and the number of abdominal segments has diminished. The thorax, thus being more prolonged posteriorly, has advanced, in a manner, to meet the centre of gravity, which remains plainly in the median region of the body; and the abdomen

* In my memoir I have given the name of the *relative position of the centre of gravity* to its position with relation to some one of the parts of the body (segment, coxa, &c.), and that of the *absolute position of the centre of gravity* to the number which is obtained by calculating the relation between the distance from the centre of gravity to the posterior extremity of the body and the total length of the animal. The quotients 0·50, 0·67, for example, obtained in this manner, signify that the distance from the centre of gravity to the posterior extremity is *five tenths* or *sixty-seven hundredths* of the length of the body. They show at once, and independently of the form and extent of the segments, whether the centre of gravity is at the middle of the insect, more approximated to the head, or nearer to the anal orifice.

becoming shortened, the distance from its extremity to the point in question diminishes.

6. In standing, the centre of gravity is placed at the base of the abdomen, or in the posterior part of the thorax, and usually at the middle of the length of the body.

7. In walking, the centre of gravity of an insect is constantly displaced around a mean position, but by too small an amount to be capable of measurement.

In fact, if we make experiments by means of Saltatorial Orthoptera (locusts or grasshoppers), we find that the movements of their enormous posterior limbs induce changes in the situation of the centre of gravity; but these changes being very slight, we arrive at the conclusion that it would be impossible to measure them in ordinary insects.

8. We do not detect any displacement of the centre of gravity when an insect passes from the position of repose to that of flight, except in those species in which the wings are decumbent or crossed upon the back in a state of repose. The displacement is horizontal and from behind forward. For example, this displacement is as follows, in the following species:—

Dytiscus dimidiatus	0·045	of the total length of the body.	
Hydrophilus piceus	0·028	,,	,,
Melolontha vulgaris ♀	0·053	,,	,,
Notonecta glauca . . .	0·032	,,	,,
Locusta viridissima. .	0·054	,,	,,
Vespa vulgaris	0·023	,,	,,
Plusia gamma	0·025	,,	,,
Eristalis tenax	0·037	,,	,,

9. During active flight the centre of gravity oscillates continually around a mean position which answers to the moments when the extremities of the wings are at the point of crossing of the figure-of-8 curve which they describe in the air.

10. In aquatic insects the centre of gravity is nearer to the lower than to the upper surface of the body.

11. During natation the movements of the oar-like posterior legs cause oscillations of the centre of gravity around a mean position, which answers to the situation of the natatory feet at the middle of their course. These oscillations of the centre of gravity induce a continual balancing of the body upon a transverse axis passing through the mean centre of gravity, and cause it, consequently, to traverse a slightly undulated path.